

What is claimed is:

1. A method of matching positions of images, in which positions of two images of a single same object are matched with each other, the method comprising the steps of:

5 i) performing approximate position matching processing with respect to entire areas of the two images,

10 ii) selecting local area limited regions, between which a degree of shift is high, in the two images, whose positions have been approximately matched with each other by the approximate position matching processing, and

15 iii) performing position re-matching processing with respect to at least the local area limited regions, which have thus been selected.

20 2. A method as defined in Claim 1 wherein the approximate position matching processing is global position matching processing for performing transform processing comprising at least one kind of processing, which is among rotating processing, parallel translation, and image size enlargement or reduction processing, on an entire area of at least either one of the two images.

25 3. A method as defined in Claim 1 wherein the approximate position matching processing is local position matching processing for:

setting a plurality of template regions, which are small regions, in one of the two images,

setting a plurality of search regions, each of which

corresponds to one of the template regions having been set in the one image and is larger than each of the template regions, in the other image,

determining a subregion in each of the search regions, in which subregion an image pattern approximately coincides with the image pattern within the corresponding template region, and

performing nonlinear strain transform processing on the entire area of at least either one of the two images and in accordance with corresponding position relationships between the subregions, which have thus been determined, and the corresponding template regions, such that the two images approximately coincide with each other.

4. A method as defined in Claim 1 wherein the approximate position matching processing is a processing comprising:

a) global position matching processing for performing transform processing comprising at least one kind of processing, which is among rotating processing, parallel translation, and image size enlargement or reduction processing, on an entire area of at least either one of the two images, and

b) local position matching processing for:

setting a plurality of template regions, which are small regions, in one of the two images, whose positions have been matched with each other in a global manner by the global position matching processing,

setting a plurality of search regions, each of which corresponds to one of the template regions having been set

in the one image and is larger than each of the template regions,
in the other image,

determining a subregion in each of the search
regions, in which subregion an image pattern approximately
5 coincides with the image pattern within the corresponding template
region, and

performing nonlinear strain transform processing
on the entire area of at least either one of the two images and
in accordance with corresponding position relationships between
10 the subregions, which have thus been determined, and the
corresponding template regions, such that the two images
approximately coincide with each other.

5. A method as defined in Claim 1, 2, 3, or 4 wherein
the position re-matching processing is a processing for:

15 setting a template region in the local area limited
region in one of the two images, the setting of the template region
being performed with respect to each of sets of the corresponding
local area limited regions in the two images, between which local
area limited regions the degree of shift is high,

20 setting a search region in the local area limited region
in the other image, the setting of the search region being performed
with respect to each of the sets of the corresponding local area
limited regions in the two images, between which local area limited
regions the degree of shift is high,

25 determining a subregion within the search region, in
which subregion a degree of image pattern coincidence with the

corresponding template region is high,

calculating a corresponding position relationship between the template region and the corresponding subregion,

iterating operations, in which sizes of the template region and the search region are reduced in stages, the template region and the search region having the sizes reduced in stages are set in accordance with the thus calculated corresponding position relationship, and a corresponding position relationship between the template region and the corresponding subregion is calculated successively, an ultimate corresponding position relationship being thereby calculated with respect to each of the sets of the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high, and

performing transform processing on at least either one of the two images, whose positions have been approximately matched with each other by the approximate position matching processing, and in accordance with the ultimate corresponding position relationships that have been calculated ultimately with respect to the sets of the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high, such that the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high, approximately coincide with each other.

6. A method as defined in Claim 1, 2, 3, or 4 wherein

the selection of the local area limited regions, between which the degree of shift is high, is performed by setting a plurality of sets of corresponding local area limited regions in the two images, calculating the degree of shift between the corresponding local area limited regions in the two images and with respect to each of the sets of the corresponding local area limited regions in the two images, and selecting the local area limited regions, between which the degree of shift is high, in the two images in accordance with the degrees of shift, which have been calculated with respect to the sets of the corresponding local area limited regions in the two images.

7. A method as defined in Claim 6 wherein the degree of shift between the corresponding local area limited regions is calculated as a total sum value of absolute values of pixel value differences between corresponding pixels in the corresponding local area limited regions in the two images, and

the selection of the local area limited regions, between which the degree of shift is high, is made by performing threshold value processing on the total sum value of the absolute values of the pixel value differences between the corresponding pixels in the corresponding local area limited regions.

8. A method as defined in Claim 1, 2, 3, or 4 wherein the two images are images, which have been recorded in a time series manner at different points of time.

9. A method as defined in Claim 1, 2, 3, or 4 wherein the two images are medical radiation images.

10. An apparatus for matching positions of images, in which positions of two images of a single same object are matched with each other, the apparatus comprising:

5 i) approximate position matching processing means for performing approximate position matching processing with respect to entire areas of the two images,

10 ii) region selecting means for selecting local area limited regions, between which a degree of shift is high, in the two images, whose positions have been approximately matched with each other by the approximate position matching processing, and

15 iii) position re-matching processing means for performing position re-matching processing with respect to at least the local area limited regions, which have been selected by the region selecting means.

20 11. An apparatus as defined in Claim 10 wherein the approximate position matching processing means is global position matching processing means, which performs global position matching processing for performing transform processing comprising at least one kind of processing, which is among rotating processing, parallel translation, and image size enlargement or reduction processing, on an entire area of at least either one of the two images.

12. An apparatus as defined in Claim 10 wherein the approximate position matching processing means comprises:

25 a) template matching processing means for:

setting a plurality of template regions, which

are small regions, in one of the two images,

setting a plurality of search regions, each of which corresponds to one of the template regions having been set in the one image and is larger than each of the template regions, in the other image, and

determining a subregion in each of the search regions, in which subregion an image pattern approximately coincides with the image pattern within the corresponding template region, and

b) local position matching processing means, which performs local position matching processing for performing nonlinear strain transform processing on the entire area of at least either one of the two images and in accordance with corresponding position relationships between the subregions and the corresponding template regions, the corresponding position relationships having been obtained from the template matching processing means, such that the two images approximately coincide with each other.

13. An apparatus as defined in Claim 10 wherein the approximate position matching processing means comprises:

a) global position matching processing means, which performs global position matching processing for performing transform processing comprising at least one kind of processing, which is among rotating processing, parallel translation, and image size enlargement or reduction processing, on an entire area of at least either one of the two images,

b) template matching processing means for:

setting a plurality of template regions, which are small regions, in one of the two images, whose positions have been matched with each other in a global manner by the global position matching processing,

setting a plurality of search regions, each of which corresponds to one of the template regions having been set in the one image and is larger than each of the template regions, in the other image, and

determining a subregion in each of the search regions, in which subregion an image pattern approximately coincides with the image pattern within the corresponding template region, and

c) local position matching processing means, which performs local position matching processing for performing nonlinear strain transform processing on the entire area of at least either one of the two images and in accordance with corresponding position relationships between the subregions and the corresponding template regions, the corresponding position relationships having been obtained from the template matching processing means, such that the two images approximately coincide with each other.

14. An apparatus as defined in Claim 10, 11, 12, or 13 wherein the position re-matching processing means comprises:

a) staged template matching processing means for:

setting a template region in the local area limited

region in one of the two images, the setting of the template region being performed with respect to each of sets of the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high,

5 setting a search region in the local area limited region in the other image, the setting of the search region being performed with respect to each of the sets of the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high,

10 determining a subregion within the search region, in which subregion a degree of image pattern coincidence with the corresponding template region is high,

15 calculating a corresponding position relationship between the template region and the corresponding subregion, and

20 iterating operations, in which sizes of the template region and the search region are reduced in stages, the template region and the search region having the sizes reduced in stages are set in accordance with the thus calculated corresponding position relationship, and a corresponding position relationship between the template region and the corresponding subregion is calculated successively, in order to calculate an ultimate corresponding position relationship with respect to each of the sets of the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high, and

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b) partial position matching processing means for performing transform processing on at least either one of the two images, whose positions have been approximately matched with each other by the approximate position matching processing, and in accordance with the ultimate corresponding position relationships that have been calculated ultimately with respect to the sets of the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high, such that the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high, approximately coincide with each other.

15. An apparatus as defined in Claim 14 wherein the staged template matching processing means is means for:

setting a plurality of small regions around each of the corresponding local area limited regions in the two images, between which local area limited regions the degree of shift is high, in at least one stage among the stages associated with the operation for reducing the sizes of the template region and the search region in stages,

calculating a corresponding position relationship between the corresponding small regions in the two images, the calculation being made with respect to each of sets of the corresponding small regions in the two images,

constraining the template region and the small regions, which surround the template region, with one another, and/or

constraining the corresponding subregion and the small regions,
which surround the subregion, with one another, the constraint
being performed with constraining forces in accordance with the
corresponding position relationship, which has been calculated
with respect to the template region and the corresponding subregion,
and the corresponding position relationships, which have been
calculated with respect to the sets of the corresponding small
regions in the two images,

calculating a new relative corresponding position
relationship with respect to the template region and the
corresponding subregion in accordance with the constraining forces,
and

utilizing the thus calculated new relative
corresponding position relationship as the corresponding position
relationship between the template region and the corresponding
subregion in each of the stages.

16. An apparatus as defined in Claim 10, 11, 12, or
13 wherein the region selecting means performs the selection of
the local area limited regions, between which the degree of shift
is high, by setting a plurality of sets of corresponding local
area limited regions in the two images, calculating the degree
of shift between the corresponding local area limited regions
in the two images and with respect to each of the sets of the
corresponding local area limited regions in the two images, and
selecting the local area limited regions, between which the degree
of shift is high, in the two images in accordance with the degrees

of shift, which have been calculated with respect to the sets of the corresponding local area limited regions in the two images.

17. An apparatus as defined in Claim 16 wherein the region selecting means performs the selection of the local area limited regions, between which the degree of shift is high, by calculating the degree of shift between the corresponding local area limited regions as a total sum value of absolute values of pixel value differences between corresponding pixels in the corresponding local area limited regions in the two images, and

performing threshold value processing on the total sum value of the absolute values of the pixel value differences between the corresponding pixels in the corresponding local area limited regions.

18. An apparatus as defined in Claim 10, 11, 12, or 13 wherein the two images are images, which have been recorded in a time series manner at different points of time.

19. An apparatus as defined in Claim 10, 11, 12, or 13 wherein the two images are medical radiation images.